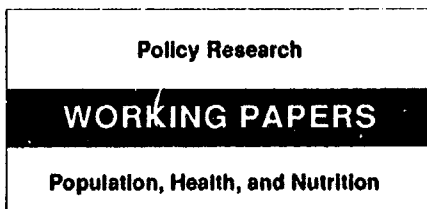


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Incorporating Cost and Cost-Effectiveness Analysis into the Development of Safe Motherhood Programs

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A relatively small investment can reduce maternal mortality and morbidity. To achieve the greatest impact on maternal health, resources must be allocated soundly within and to Safe Motherhood programs.

This paper — a product of the Population, Health, and Nutrition Division, Population and Human Resources Department — synthesizes the results of a workshop on the costs and cost-effectiveness of Safe Motherhood programs. The workshop was held at the World Bank, April 8-9, 1991. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Otilia Nadora, room S6-065, extension 31091 (37 pages). January 1992.

Little information is available on the actual costs of implementing Safe Motherhood programs, or on how these costs vary in different settings. Nor is there a consensus on the precise goal, content, and structure of Safe Motherhood programs — due largely to a paucity of information on the relative effectiveness of individual health interventions; of different levels of the health system; and of non-health sector interventions. It is difficult to measure the impact of interventions on mortality, and debate continues on the appropriateness of various intermediate or process indicators as proxies for maternal outcome measures.

Participants at a recent World Bank workshop on Safe Motherhood agreed that it is essential to develop a better understanding of the cost-effectiveness of Safe Motherhood interventions to design programs and allocate the limited resources available in a way that maximizes their impact on maternal health status.

At its simplest, a costing methodology would provide guidelines for estimating the costs of prospective programs, once designed. When combined with information on effectiveness, it

could be used to give planners an indication of the potential results achievable through a variety of program options, subject to the resources at their disposal.

Traditionally, program design decisions have been based on assumptions about the potential impact of alternative strategies, with little explicit consideration of their costs. The workshop aimed to lay the groundwork for incorporating cost data into the program design. But lack of knowledge on the effectiveness of interventions is nearly as great an obstacle to sound program design. A much improved information base in both areas is urgently needed.

Cost-effectiveness information is also essential to ensure that additional resources are allocated to Safe Motherhood by illustrating that a relatively small investment can bring about significant reductions in maternal mortality or improve other key indicators. Safe Motherhood competes with other better established sectoral interests, including Child Survival, which regularly uses cost-effectiveness figures as advocacy and fundraising tools.

The Policy Research Working Paper Series disseminates the findings of work under way in the Bank. An objective of the series is to get these findings out quickly, even if presentations are less than fully polished. The findings, interpretations, and conclusions in these papers do not necessarily represent official Bank policy.

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I. INTRODUCTION

Maternal mortality is now the greatest indicator of continuing disparities in health status between developed and developing countries. Each year, 500,000 women die from complications related to pregnancy or childbirth. Ninety nine percent of these women live in the developing world, where the risk of maternal death is 50-100 times greater than that faced by women in industrialized countries. Many more women survive pregnancy and childbirth only to suffer serious illness and disability. Maternal mortality and morbidity have been neglected during a period of otherwise remarkable progress in improving developing country health status. The Safe Motherhood Initiative, which was launched at an international conference in 1987, aims to reduce maternal mortality by 50 percent by 2000.

This report synthesizes the results of a workshop on the costs and cost-effectiveness of Safe Motherhood programs. The workshop, which was held at the World Bank, April 8-9, 1991, brought together economists, maternal health and family planning professionals, and staff from several multilateral agencies to discern what is known about the components and costs of Safe Motherhood programs, and to lay out the agenda for future work on this issue.

The goal of the workshop was to begin working towards identifying the conceptual basis for a cost-effectiveness methodology for Safe Motherhood, for use by health planners working to develop and implement programs in developing countries. While costs were the primary focus of the workshop, it also aimed to identify gaps in our current knowledge of the efficacy of program options, which will need to be addressed before a general model of cost-effectiveness can be developed and applied in practice. Such a model would be designed with several purposes in mind:

- to serve as a method of estimating the resources required for Safe Motherhood interventions and programs;
- to provide estimates of potential results achievable with a given level of expenditure;
- to permit comparisons among technologies, delivery mechanisms, etc;
- to indicate what might be the optimal set of interventions, in terms of cost and effectiveness, for the social, economic, and demographic characteristics of a particular country;
- to improve planning, resource allocation, monitoring, efficiency and equity;

Traditionally, decisions about program design have been based on assumptions regarding the potential impact of alternative strategies. Maximizing the benefit of scarce health resources, however, requires that cost be considered along with effectiveness in program design. Resource constraints, existing infrastructure, the skill levels of health personnel, and other issues will also affect the ideal balance of further investments. In particular, it is essential that Safe Motherhood goals be united with broader health sector objectives, and that related remedial strategies be integrated with existing programs.

The goal of this workshop was to lay the groundwork for incorporating cost data into the decision-making process. However, one of the major barriers to designing programs on the basis of cost-effectiveness is lack of accurate knowledge of the effectiveness of many interventions, as well as lack of knowledge of their costs. At its simplest, a costing methodology would provide guidelines for estimating the costs of prospective programs, once designed. When combined with information on effectiveness, it could be used to give planners an indication of the potential results achievable through a variety of Safe Motherhood program options or combinations of interventions, subject to the resources at their disposal.

The first step in the development of a cost-effectiveness model is to attempt to define the relationship between the resources used and program outcomes, (reductions in maternal mortality, for example.) This relationship is difficult to define in the health sector, and perhaps more difficult in Safe Motherhood. The most important direct causes of maternal mortality are hemorrhage, pregnancy-related hypertension, infection, obstructed labor and the sequelae of unsafe abortion. These problems stem not only from inadequate health and family planning services, but also from the social, cultural and economic environment in which women live. As a result, the largest reductions in maternal mortality could be achieved through a combination of socioeconomic change and direct health sector interventions. The relative effectiveness of health-sector interventions and non-health sector interventions, of different levels of the health care system, and of different interventions, however, is a subject that generates continued debate. There is now growing consensus that direct maternal health care and family planning interventions will have the most impact in the short term, though changes in women's status are important long-term goals. Accordingly, efforts should focus on ensuring the availability of a carefully coordinated set of interventions at the community and referral levels, to prevent pregnancy, to prevent maternal complications, and to recognize and efficiently treat them when they occur.

There is little consensus, however, on which maternal care interventions are most effective, nor on the ideal balance between them. Indeed, the efficacy of many interventions is not yet proven. If maternal health care is indeed the most effective means of reducing maternal mortality, to what extent should resources be concentrated on providing emergency obstetric care to women suffering complications during delivery, or on preventing or managing these complications through improved, routine pre-natal and delivery care and community-level education on the issues surrounding pregnancy? What are the components of an ideal pre-natal care program? To what extent should resources be concentrated on training traditional birth attendants, increasing the number of trained midwives, or on improving the distribution of

physicians? How do the answers to these questions vary in different socioeconomic, demographic, and cultural settings? Since impact on maternal mortality is often difficult to measure, how do we determine the impact of alternative interventions? What intermediate or process indicators, or combination thereof, serve as the most accurate proxies?

It should also be noted that Safe Motherhood activities accomplish a wide range of health and welfare goals beyond maternal mortality reduction, including reductions in maternal morbidity rates and improvements in infant and child survival and welfare. Many studies focus on mortality because of the difficulties of morbidity measurement. A program designed with the sole objective of reducing mortality, however, may differ enormously from a program designed to reduce maternal mortality and morbidity, and even more if child health goals are also included. Insufficient consensus on how broad the goals of the initiative should be impedes development of specific goal-oriented strategies.

While it is important for Safe Motherhood programs to determine and focus on specific goals, it is also important to emphasize and document that improving women's health will also reap considerable benefits for society in general. Reproductive mortality and morbidity have severe consequences for the infant the woman was trying to bear, for her other children, for the community in which she lived, and for the development prospects of the nation to which she made important, though often unrecognized and undervalued, productive contributions. Thus, benefit/cost analysis, by quantifying and valuing in monetary terms the magnitude of benefits to be gained from spending on Safe Motherhood programs, may provide major support for Safe Motherhood programs by illustrating the social benefits of reducing maternal mortality. Measurement of the social benefits of women's lives is proceeding elsewhere, including the Women in Development division at the World Bank. For the moment, systematic quantification of benefits remains only a distant possibility.

The next section of this report summarizes the history and activities of the Safe Motherhood Initiative. The following section discusses workshop participants' perceptions of the components of Safe Motherhood programs and possible measures of effectiveness. This is followed by a discussion of costing information and possible data sources. Finally, a specific economic modeling activity is outlined, with additional detail provided in the report appendix.

II. BACKGROUND ON THE SAFE MOTHERHOOD INITIATIVE

The Safe Motherhood Conference held in Nairobi, Kenya in 1987, succeeded in drawing global attention to the magnitude, causes, and societal implications of maternal mortality and morbidity; subsequent advocacy and planning activities have succeeded in mobilizing regional- and national-level policy-makers, resulting in changes in health policy emphasis and the development of programs. The Initiative is formally co-sponsored by the International Planned Parenthood Federation, the Population Council, the United Nations Development Program, the United Nations Population Fund, United Nations Children's Fund, the World Health

Organization, and the World Bank. The Center for Population and Family Health at Columbia University, Family Care International, the London School of Hygiene and Tropical Medicine and the MotherCare Project of John Snow, Inc., have also been very active in the initiative, through advocacy and information dissemination, research efforts related to the development of relevant policy and programs, and national-level technical assistance.

Among the documentation for the Nairobi conference was The Safe Motherhood Initiative: Proposals for Action, by Barbara Herz and Anthony Measham. This seminal document set out possible configurations for Safe Motherhood programs with varying components and assumed impacts, and attempted to determine their costs. This paper was developed as an advocacy tool for policy makers as well as a preliminary framework for technical/project level personnel, to encourage the collection of the basic data, and promote further work toward incorporating cost considerations into the program design process.

A number of other activities are underway which aim to generate more information for the development of programs. WHO manages the Safe Motherhood Operations Research Program (SMOR), for example, which seeks to identify and evaluate ways to strengthen existing maternal health and related services. Columbia University has compiled a chartbook reviewing the evidence on pregnancy-related mortality and the efficacy of proposed remedial strategies, to help guide policy and program development and identify remaining research needs. Numerous other individuals, governments, NGOs and intergovernmental organizations are involved in research, advocacy, education, and policy and program development activities in the field.

III. COMPONENTS OF A SAFE MOTHERHOOD PROGRAM

A conceptual framework for Safe Motherhood programs, incorporating efforts to address women's status (education, employment, changes in law and cultural practices), family planning, maternity care, community mobilization and education, abortion, and health care for women, was presented as a general guide. There was considerable discussion on the extent to which the Initiative should focus on family planning as opposed to specific maternity care, as well as on the relative efficacy of the preventive and curative components of maternity care. The point was made that if the primary goal of the Initiative is to reduce maternal mortality, then in most settings maximum benefit will be derived from concentrating on the provision of maternity care. That is, programs should focus on reducing the risks associated with pregnancy and childbirth, thereby ensuring successful completion of desired pregnancies. In areas where contraceptive prevalence is low, however, the provision of family planning will have considerable impact on levels of maternal mortality by reducing the numbers of high risk and unwanted pregnancies and, especially, the incidence of unsafe abortions. This discussion highlighted the importance of identifying the goals (and the effectiveness measures) of a program prior to costing exercises.

Maternity care interventions are likely to work best when provided jointly. In other areas of the health field, such as Child Survival, much can be achieved through single interventions such as Oral Rehydration Therapy (ORT) and immunizations; in family planning, much can be accomplished by providing contraceptive supplies. In the case of maternal mortality, however,

prenatal and delivery care at the community level need to be combined with essential obstetric care and alarm and transport systems to ensure that women receive this care in time. It is not an issue of prenatal versus referral level care. Because individual program components operate synergistically, it is important to look at the cost-effectiveness of a variety of packages reflecting different balances of all components, rather than determine the cost-effectiveness of individual components. Some workshop participants argued that the entire package must be implemented simultaneously. Others felt that if a choice between components had to be made, emergency obstetrics should receive priority. Still others felt that while the whole package was desirable, a phased approach beginning with prevention and management at the community level would provide significant benefits even in the context of poorly developed referral-level care. A recent program in the Matlab district of Bangladesh, for example, where trained midwives were posted in the community, brought about a 68% reduction in maternal mortality in only three years.

This discussion of program components and priorities was supplemented by the presentation of an "epidemiological program-level model" of maternal mortality based on the five leading direct causes of death (hemorrhage, infection, abortion, obstructed labor, and eclampsia), which is being developed at WHO. The model relates maternal deaths from a specific cause to the following: demographic indicators (e.g. population, married women of reproductive age); indicators of pregnancy rates, wanted and unwanted (e.g. proportion of sexually active women, abortion ratio); rates of pregnancy-related complications (e.g. severe anemia); proportion of births attended by different categories of health care providers; prenatal care coverage indicators; indicators of mortality by cause of death; and relative risk of mortality for women with specific risk factors (e.g. relative risk of mortality for women suffering cephalopelvic disproportion).

Preliminary results from the WHO clinical model emphasize the important link between screening and referral, suggesting a need to move essential obstetric care (EOC) closer to the community level. Not only is quality EOC only available at the pinnacle of the health system in many settings, the essential link between communities and the district level (the health center level) is often weak, making it difficult to ensure that complicated cases and emergencies are effectively referred even when EOC is available. The number of midwives, in both absolute and relative terms, is falling, making this link less functional. It must be reiterated, however, that certain complications of pregnancy and childbirth could be prevented and/or managed at the community level.

Each cause of maternal death has many potential underlying causes. Sound program design and resource allocation decisions are impaired by the fact that we do not know the proportion of hemorrhage deaths, for example, that are attributable to severe anemia, abortion, retained placenta, placenta previa, etc. Some of these conditions can be prevented or dealt with effectively by non-physicians at the community level. Others require more sophisticated equipment and the attention of a physician, and must be dealt with at higher levels of the health system. Lack of information on the proportion of deaths attributable to each underlying cause impairs our ability to determine where limited resources should be concentrated to achieve maximum impact.

With this background, discussion centered on what is known of a specific model of Safe Motherhood programs. Presentations by several field workers provided various insights on factors affecting maternal health, implementation issues, and indicators of successful interventions.

A model of maternal health factors and their impacts, developed at Columbia University, identifies the range of Safe Motherhood program options and traces their impact on mortality through intermediate factors, which include health and reproductive behavior, health status, and access to health services. These intermediate factors will then have an impact on one or more of the model's three outcomes:

- Incidence of pregnancy
- Incidence of complications among pregnant women
- The outcome of complications that arise.

An appropriate set of activities to achieve these outcomes was suggested by a **programmatic model** presented by the MotherCare Project. The major components of the MotherCare program include:

- **building community awareness** to promote recognition of danger signs and increased use of services;
- **enhancing services and training** through improved supervision in EOC, family planning, counselling, prenatal and postnatal care;
- **upgrading/maintaining facilities;**
- **and developing the referral and information system**, through systems of meetings between levels of the health care system, communications, and transport.

The appropriate balance of the above activities would be based on the conditions in the country or region in which the program is to be implemented. Three general typologies can be derived from the MotherCare experience, which illustrate how existing infrastructure, as well as knowledge, attitudes, and practices, help determine the most appropriate program mix. These include:

1. Rural area; no doctor; no formal health care infrastructure; deliveries attended by untrained personnel, family members.

Program focus: community awareness building and training; hospitalization is not possible therefore program focuses on changing behavior surrounding pregnancy and delivery.

2. Limited rural health services and referral infrastructure; low utilization rates; most

deliveries attended by TBAs.

Program focus: enhancing awareness; training TBAs, upgrading facilities; improving referral system.

3. Urban area; many public and private facilities but low quality and underutilized.

Program focus: IEC to build demand for services, training to improve quality of care.

Indicators of success in these programs were suggested by the Columbia University model. Program impact in the three areas can be assessed by the following measures:

- **reducing maternal mortality by preventing pregnancy:** increased contraceptive prevalence or effectiveness, reduced fertility rates;
- **reducing maternal mortality by preventing complications:** improved hygiene and delivery practices, improved knowledge, attitudes and practices, reductions in complication rates;
- **and reducing maternal mortality by improving treatment of complications:** improvements in women's condition on arrival at referral facilities, reduced case fatality rates;

The workshop also included a general discussion about the importance of perinatal mortality and other possible health indicators that one could include in the evaluation of Safe Motherhood programs. Programs that aim to reduce maternal mortality and morbidity will also have an impact on other health indicators, most notably perinatal mortality, or those deaths that occur between 28 weeks pre-birth and seven days postpartum. Twenty-five to 30 percent of the 2.5 million perinatal deaths that take place each year could be prevented through quality maternity care, and more in those areas where maternal mortality is highest. Data from Bangladesh, for example, indicate that training traditional birth attendants can reduce neonatal mortality by as much as 60 percent. In addition, women who experience and survive severe maternal complications will frequently have asphyxiated infants. Approximately one million infants die a year due to asphyxia, and as many as two to three million survive with severe disabilities, including cerebral palsy, seizure disorders, and learning disabilities.

Following are examples of other Safe Motherhood program components that have an impact on perinatal mortality (as well as on infant and child mortality, and overall child health and welfare):

- family planning - - particularly through birth spacing;

- prenatal care - - primarily by improving nutrition during pregnancy and preventing low birth weight;
- neonatal tetanus immunization programs;
- sexually transmitted disease programs -- Syphilis infects 10% of women in many areas of Africa. These women have 20-30% miscarriage rates, 10% stillbirth rates;
- and malaria programs (malaria can lead to low birth weight and miscarriages, especially among primiparas).

While it was argued that perinatal mortality reduction should be included in effectiveness measures, it was recognized that this would present a number of problems. The ideal intervention to promote perinatal health may have no consequences, or even negative consequences, for the woman's health. Also, assessing multiple outputs may require changing the inputs. If perinatal mortality reduction and other infant and child health objectives are included as explicit goals, the optimal package of care is likely to differ. Indeed it may differ in ways that reduce its impact on women's health. It was argued, however, that including perinatal and infant mortality and child health outcomes improves the cost-effectiveness of women's health programs dramatically, and, as such, we cannot afford to exclude them. This is particularly true in the consideration of resource allocation across the entire health sector. Multiple outcomes cannot be ignored in resource allocation decision making. Indeed, reducing maternal morbidity is also an essential Safe Motherhood objective, and the optimal content of a program designed to reduce maternal mortality and morbidity will differ from a program designed to reduce mortality alone.

It is essential that consensus be achieved on the specific goals and thus components of the Safe Motherhood Initiative, and that more information be gathered on the relative efficacy of alternative interventions for achieving these specific goals, in order that cost-effective programs may be designed.

IV. MEASURING SAFE MOTHERHOOD COSTS

Several workshop participants noted that there is no mystery to measuring costs. The difficult part is in deciding what services to provide -- where and how to handle hemorrhage, for example. Once judgements on the latter have been made, the analysis simply requires collecting the relevant field-level cost information. This is costing at its simplest: estimating the costs of prospective programs, once designed. Optimally, however, planners need an indication of the potential results achievable through a variety of Safe Motherhood program options or combinations of interventions, subject to the resources at their disposal, which implies building costs into the design process.

Collection of cost data can and must be incorporated into all kinds of operational research. Indeed, some data collection is beginning as programs get underway. For the most part, these efforts have followed the process outlined in the paper by Herz and Measham:

- Define basic unit of care (eg. Health Post).
- Make judgements about what interventions work best to achieve desired outcomes.
- Determine how many and what types of staff will be needed, and at how many posts, to carry out these interventions.
- Calculate the costs of staff; transport (maintenance, gas); in-service training and supervision; equipment and supplies; health education; and monitoring and evaluation.

This general approach was necessary in the early stages of Safe Motherhood programs because it allowed for estimation when reliable cost data were not available. With program experience since 1987, it is now possible to construct more accurate field-based estimates. A common framework for data collection, with categories that can be used across different projects, will facilitate this process and help ensure the comparability of results. Categories include:

- Inputs: These include staff time, vehicles, equipment, and other resources essential to providing services.
- Input prices: Each input will have a cost associated with it. This is the price that the project, Ministry of Health, or other source must pay to use it.
- Services: These are the activities accomplished by the project. Services are provided by using inputs, and their costs are the total spent on the inputs used. Examples of services would include women provided emergency transport or increased number of birth attended by midwives.
- Outcomes: These are the changes in health status caused by the program. Examples might include mortalities and morbidities prevented through provision of services, or such measures as discounted healthy life years (DHLs).

The primary advantage of calculating costs from basic input prices is that it facilitates the comparison of alternative programs. Safe Motherhood programs can vary in either the type and quantity of inputs used to provide a service, or in the type of services offered. In both cases, it is possible to determine costs by adding up the number of inputs used multiplied by input prices.

Once basic categories have been defined, and data gathered, a number of the most common summary cost measures can be derived. Moreover, it is possible to develop these cost measures for a variety of programs, allowing comparisons across approaches. Common measures include the following types:

- Cost per capita population: often used by Primary Health Care programs.
- Cost per woman of reproductive age: often used by family planning programs. For Safe Motherhood programs, it is useful for an analysis of resource distribution, but it is not useful for cost-effectiveness analysis.
- Cost per birth/pregnancy: analysis should not be limited to this measure as it prevents comparability to more common per capita measures.
- Cost per service delivered: cost per woman receiving essential obstetric care, prenatal care, or other service. This is a practical cost measurement, useful for planning purposes. Its calculation can be important for deciding among alternative programs.
- Cost per outcome. This is the most significant cost in terms of maximizing the benefit of scarce resources. But unless a controlled experiment has been conducted, or multivariate analysis has been used to account for the contribution of other variables (e.g. income or education levels), we cannot say with any certainty that the outcomes achieved are attributable to the program. This is particularly true in the field of women's health, as many non-health sector interventions must have an impact.

Data should be collected at different units/levels of operation. Most importantly, and as stated above, costing must be seen as part of a wider evaluation process. Cost data needs to be related to information on effectiveness to be of most value. Many of the measures above can be used in cost-effectiveness analysis. By defining possible sets of activities that can achieve the desired goal, one can examine the lowest cost approach per pregnancy, service delivered, or per outcome.

The collection of this data will require planning to determine carefully both the types of data required and the most appropriate sources. Cost data are needed on the health care system itself, non-health sector specific inputs (e.g. administration), and service users (including demand assessment). Data collection can be guided by the determinants listed in the Columbia University model and the implementation needs indicated by the MotherCare approach. Several different collection strategies can be used:

- Routine data/records. These can come from health facilities, central or sub-national offices, or from other sources, such as price lists for equipment and

supplies.

- Special surveys, including the assembly and analysis of data from existing surveys and the collection of primary information. Data should be gathered in a variety of different geographical areas and at varying levels of demand and program scale so that the full cost function can be derived.
- Sentinel site monitoring -- or monitoring pilot projects to use as a guide for the probable costs of larger scale work -- can be used to get quick results.

A number of possible data sources were identified during the workshop. The Columbia University group is involved in a number of projects in Africa that could provide relevant data. The World Bank itself has several Safe Motherhood projects in various stages of approval and implementation that could incorporate a cost data component. A major Bank project in India, for example, has recently been approved and could provide an ideal opportunity. The MotherCare Project and Family Care International are also interested in gathering cost data as part of ongoing Safe Motherhood program development and evaluation in a variety of countries and regions. There are several countries with a variety of activities underway on the government, NGO and donor side; potential sites for rigorous data collection efforts include Bangladesh, Tanzania, Nigeria, Indonesia and Gambia. Indeed, since the conclusion of the workshop, costing studies have evolved in Bangladesh, Indonesia, and the Gambia.

V. COST MEASUREMENT: FURTHER METHODOLOGICAL ISSUES

There are a number of precautions that must be taken if cost analysis activities are to be successful. Among the most important of these precautions is the way in which costs are measured. One common pitfall is to rely solely on the use of total cash outlays on program inputs, rather than attempt to analyze the costs associated with specific outputs. Using measures of expenditure rather than cost does not allow for inefficiency or unused resources; that is, it assumes that the expenditure did achieve the desired outcome. Nor does this method allow one the ability to project the costs of a different set of services. An alternative is to derive estimates from institutional and government records, reconstructing costs using a step-down methodology. This methodology is based on scrutiny of the production process, which then enables attribution of all hospital expenditures, for example, to specific departments ("cost centers") and the distribution of all costs (including overhead and the costs of intermediate outputs) to final service categories using allocational criteria, such as time use.

An advantage of this step-down methodology is that it more closely approximates economic costs of resources than do accounting costs. Economic costs, often referred to as opportunity costs, are the benefits foregone by not using a resource in its next best alternative. Unless the true costs of a resource are used, the true minimum cost solution cannot be determined. Often, private cost is a good measure of the opportunity cost of a resource. At times, however, market prices do not reflect the opportunity costs of a resource, for a variety

of reasons. Some program inputs have a heavy foreign exchange requirement (eg. pharmaceuticals, equipment), which have traditionally been incorrectly valued at official exchange rates. Similarly, the cost of labor in many countries may be incorrectly valued by "market" wage rates. A technique known as shadow pricing is used to determine the real economic price of a good or service where no market price exists or where it is distorted. In the past, the use of shadow prices has discouraged projects which used scarce foreign exchange and encouraged labor intensive projects. "Social prices" can also be used to reflect social values and balance equity and efficiency goals. Ideally, costs to the consumer should also be included in the estimation process (e.g. the cost of travel and waiting time, which represent wages forgone, or an alternative measure of the value of time in non-wage economies).

A further issue concerns the use of marginal rather than average costs. Average cost is the cost of producing a given output divided by the number of units produced. Marginal cost is the added cost of producing one more unit, and is the relevant measure to use when making resource allocation decisions. This is because decisions are typically made on marginal changes, such as adding or subtracting an activity from an existing set of activities. There are, however, situations in which programs do start from scratch or undergo significant expansion. When a program can operate at varying sizes, the question of how large to make it is still a matter of marginal analysis. In cases where programs have a relatively fixed size and cannot be adjusted, such as the decision to build a health center, it is necessary to consider the total cost of the program in determining whether to undertake it at all.

When examining the production of services, it is also important to keep in mind possible economies of scale or scope. General economies of scale occur when one encounters increasing or decreasing unit costs of output as the volume of output changes. Product-specific economies of scale occur when the expansion of one activity causes a more than proportional expansion in desired output. Economies of scope can occur when it appears that adding a service, such as Safe Motherhood, to an existing activity set can lower unit costs across the full range of services.

In many health sector activities, unit costs are found to decline as programs are scaled up and the costs of initial capital investment are spread over larger and larger numbers. While this may occur in the early stages of an activity, there can also be significant diseconomies of scale, with unit costs rising as scale increases. Prenatal care programs provide an example. Once those women within easy reach have begun using the services, greater coverage can only be obtained by extending services to women who are more difficult to reach. Unit costs can also rise as health programs become too large to administer efficiently, a problem frequently encountered when successful pilot projects are implemented on a larger scale.

Finally, it is important to keep in mind that while unit costs may not vary, the total costs of an activity may vary considerably if the volume of services demanded are not accurately forecast. In order to estimate the costs of Safe Motherhood programs accurately, it is essential to define the specific target group and estimate expected demand for services. As there is often a wide margin of error, a range of cost estimates for varying demand or output levels should be

calculated. Reducing unit costs by increasing demand may require increasing total costs. For example, if a health unit is constructed, equipped, supplied and staffed, but underutilized, unit costs will be high. The additional costs of stimulating demand may preclude the possibility of filling the facility to capacity and reducing unit costs.

VI. A GENERAL MODEL OF COST AND COST-EFFECTIVENESS

An immediate objective of the workshop was to lay the groundwork for incorporating cost considerations into the design of Safe Motherhood programs. There are, of course, numerous ways of analyzing such programs, each with its own framework for analysis. Up to this point, these programs have been examined mainly in terms of clinical outcomes. This "medical" approach attempts to define the causal relationships between maternal mortality and its proximate determinants. It then seeks to determine what effect various interventions have on these determinants. Such models require careful understanding of the biological and demographic processes at work in maternal mortality, in a significant amount of detail.

An economic analysis of maternal health attempts to address different questions, and therefore examines the same issues from a different perspective. It builds on the medical approach to maternal health, both simplifying and extending it. It simplifies the model in that it accepts the correlations between interventions and effects without incorporating the complicated biological or demographic processes detailed therein. At the same time, it extends the medical model by building resource considerations into the analysis. Like the medical model, the economic model can be used for decision making. Unlike the medical model, however, economic models can be used for a process known as *optimization*. Optimization is the process of determining the most efficient use of available resources. It is predicated on the assumptions that resources are limited, and that one must find a way to allocate them to achieve the greatest effect.

An economic model of Safe Motherhood will specify a relationship between the resources used (inputs) and the possible results (outcomes). Inputs include training, vehicles, staff, pharmaceuticals. Depending on the purposes of the costing exercise, non program inputs such as women's information, time, and financial resources will be important measures. Inputs are combined into interventions to produce outputs, which can be defined as intermediate service outputs, such as increased family planning service coverage, midwife attendance at deliveries, or coverage of prenatal care; or as ultimate outcomes, such as reductions in the incidence of pregnancy, reductions in rates of pregnancy-related complications, or improved management of complications. The model also requires specification of the input costs. Using these two pieces of information, an economic model can be "solved" to indicate the minimum cost method of achieving any desired level of results, or the maximum impact achievable with resources available. Borrowing from the medical model, interventions can be seen as a way of associating resources used, such as staff time, vehicles, etc. with impact, such as decreased mortality.

The important point about this form of analysis is that the information about production of outcomes is combined with information about costs to find the *optimum*, the particular combination of resources that keeps costs to a minimum. This is important, from a cost-effectiveness standpoint, because planners may not systematically incorporate information on both costs and effectiveness into their judgements about appropriate program interventions. It is possible, and likely, that different interventions will be optimal under different cost conditions. The following simple example will illustrate the point.

Suppose that our medical model has indicated that the time between the identification of a complication and treatment at a referral facility is very important to reducing maternal mortality. Suppose we also know that the time interval could be reduced in several ways, including creating more referral facilities, increasing the capacity of the emergency transport system, establishing maternity waiting homes, deploying mobile units, and other possibilities. What is the cost of reducing transport time? The appropriate method is to determine the cost per unit of time (say per one hour reduction) from each of the possible interventions. The lowest cost method is the lowest current cost of reducing transport time by one hour.

There are several important points that will affect the conclusion reached in this example. First, it is based on current levels of all interventions. That is, it is the marginal cost of reducing transport time under current conditions. If the number of referral facilities or number of vehicles in the current system were different, you would probably arrive at a different minimum cost solution. Second, in addition to effectiveness, the solution is based on the cost of the interventions, which is based on the costs of the intervention inputs. If the price of labor in referral facilities went up and the price of vehicles went down, you might very well decide to build fewer referral facilities and use more vehicles to achieve the same decrease in transport time. Third, for large reductions in transport time, the optimal solution is probably a mixture of several interventions. The first investment may be in more vehicles, but as you invest in more vehicles, the associated decrease in transport time may level off. Creating more referral facilities may then be just as attractive an option. The fundamental rule for cost-effectiveness is to invest in each intervention until the effectiveness of the next unit of expenditure is equal for each intervention.

How much should be spent in total on these interventions? Ideally, one should invest until the value of a life saved is equal to the cost of reducing transport time enough to save another life. In reality, this quantity of expenditure probably is not available. When this is the case, the optimal quantity of expenditure on transport reduction is found using the same rule of equating the benefit derived per amount spent on all activities. That is, assuming that there are other ways of reducing mortality, one would invest in transport until the number of lives saved per dollar invested equals the number of lives saved per dollar invested in other activities. If this were not the case, one could always save more lives with the same expenditure by taking money away from less productive activities and investing it in more productive activities.

This example illustrates a point made several times during the workshop, where it was suggested that costs are driven by the choice of program components and related inputs. The

choice of program components, in turn, must depend to a certain extent on the cost of inputs. For example, the relative abundance of labor in most developing countries may imply that decentralization of many health programs, and reliance on a large cadre of community-level health workers rather than a smaller cadre of more highly skilled health workers, is most cost-effective. Where labor is relatively expensive, it may be most cost-effective to centralize certain program components. Input prices are integral to the choice of program content.

A major advantage of an economic model for Safe Motherhood is that it incorporates medical, biological, epidemiological, social and behavioral information, as well as cost data, into a methodology that is able to consider not only single interventions but an intervention package organized into a unit of service. There are several possible model formulations, a few of which are discussed below.

The simplest and most often used approach consists of a single equation which relates inputs to a single output. This production function is combined with information about input costs to form a second relationship known as a cost function. The cost function provides the answer to the question: for any given level of output, what is the least cost way of producing it, and what will it cost?

The difficulty of relating inputs to outputs in the context of Safe Motherhood derives from the complexity of related programs. In particular, it is difficult to define a production function when more than one type of output is being produced. For this reason, several more complex approaches can be considered. Among the possibilities are linear programming, input-output models, and various non-linear approaches. All these approaches have in common the ability to find a cost-minimizing optimum use of resources, and are discussed in more detail in the appendix to this report.

One difficulty with the use of optimization models at this stage is our lack of knowledge of the effectiveness of interventions, as discussed above. That is, we do not have a clear measure of the relationship between program inputs and outcomes. As a result, workshop participants concluded that it was more feasible to set goals in terms of services delivered rather than health outcomes, defining relationship between services and health outcomes on the basis of expert opinion.

At this stage, therefore, it would make sense to consider a limited number of program models applied to comparable population bases, each of which would adopt a different combination of activities and approaches, and to assess costs and effectiveness in a standardized manner. This common approach has been used to compare alternative health sector strategies in a variety of areas -- alternative vaccination strategies, for example. These can include routine services, routine services supplemented by campaigns, static or mobile services, and other types of delivery. In the context of Safe Motherhood, one could compare varying degrees of emphasis on community-based and referral services, for example.

This sort of typology approach has already received considerable attention from the

USAID MotherCare project. Country programs are assumed to vary among a set of typical approaches. Evaluating these approaches allows for more intense scrutiny of the most widely used alternatives.

Given the limitations of current data and knowledge, a number of field studies are warranted. Data need to be collected from a variety of projects on inputs, prices, services delivered, and, if possible, health outcomes. These studies will help to define the continuum of possible Safe Motherhood programs represented by existing work. As data become more available, it will be possible to develop more reliable cost-effectiveness metrics to apply to both existing and proposed programs.

VII. CONCLUSIONS

Workshop participants concluded that we have little information on the actual costs of implementing Safe Motherhood programs, and on how these costs vary with program structure and country settings. It is also clear that we are far from consensus on the precise goal, content, and structure of "Safe Motherhood Programs." This is due, to a large extent, to the paucity of information on the relative effectiveness of individual health interventions; different levels of the health care system; and non-health sector interventions. Program impact on mortality is very difficult to measure, and debate continues on the appropriateness of various intermediate or process indicators.

Apart from the logic of ensuring that operational resource allocation decisions within Safe Motherhood are as sound as possible, it is important to ensure that resources are allocated to Safe Motherhood at all by illustrating that reductions in mortality (or improvements in other key indicators, if mortality reduction cannot be measured directly) can be brought about with a relatively small investment. Safe Motherhood competes with several other better established sectoral interests, Child Survival for example, which use cost-effectiveness figures regularly as advocacy and fundraising tools.

The participants noted that applied research will be vital to developing a better understanding of Safe Motherhood costs. It will also be essential to determine the cost and impact of a range of care packages in different settings, which will enable us to gain a fuller understanding of the economic aspects of Safe Motherhood programs. We need to identify program elements and effectiveness measures; norms and standards, to accompany coverage indicators to give some measure of quality, and thus impact; and, ultimately, comparable indicators of outcome. In addition, it will also be essential to develop a workable, common framework of categories and indicator for inputs, activities, and services, in addition to outcome. The lack of such indicators constitutes one of the greatest barriers to the confident use of costing in Safe Motherhood and to the comparability of results.

There was considerable debate on the relative importance of rigorous research. Some

participants felt that the priority was to show that maternal mortality can be reduced, in a variety of settings, quickly and at minimum cost. There was recognition of political impediments to using scarce resources for research, and of the importance of using ongoing and planned surveys whenever possible.

Others felt that in a limited number of settings, tightly-controlled demonstration projects should be undertaken, as it is imperative that we be able to make fully informed judgements on the best approaches to reducing maternal mortality under different circumstances, and to argue convincingly for greater allocation of resources to Safe Motherhood. It was concluded that a balance should be reached between rigorous research efforts in a limited number of settings and a range of smaller-scale, less costly studies of a variety of demonstration projects in different settings. Participants noted, however, that there are some problems with data from pilot projects, which are often self-selected and not always representative. Nor are they always replicable: their success or failure is often based on a few key personnel or other unique attributes.

All agreed that there is no substitute for some investment in the data collection process. Intensive field-level work will be required to "tease out" the data, which, however important, is tedious, time consuming, and expensive. There may be costing success stories we can learn from, as well as costing approaches that can be incorporated into this work. There are also model programs operating now that were not in existence in 1987, which should be identified and used for costing research. The existing network of health economists should be encouraged to work on this issue in collaboration with other social scientists, epidemiologists, and health care professionals. There was consensus that the World Bank should continue its work in this area, in collaboration with other agencies; indeed there may be prospects for Bank financing for project research components. Several other donors expressed a willingness to be more involved in costing activities, and Columbia University, the MotherCare Project, and Family Care International suggested collecting data in pilot projects in which they are involved.

One difficulty noted for costing work was the basic difference in approach between physicians and economists. Physicians are trained to do the most that they can for each individual patient without regard to resource constraints; this is central to the medical ethic. Economists are trained to make the best choices subject to those constraints; while this may not maximize the welfare of each individual, it should maximize social welfare. It was noted that it is essential that more doctors and economists gain an understanding of one another's perspective.

The role of the Safe Motherhood Operations Research Program (SMOR) of WHO was also discussed. To evaluate the effectiveness of interventions, WHO has convened six technical working groups dealing with the four major causes of mortality, health systems, and epidemiological, social and behavioral aspects of maternal mortality. The need for SMOR to be more proactive in the costing arena, as an essential component of operations research, was emphasized. WHO's role would be greatly enhanced if an economist were added to its operational research staff.

The information gaps discussed in this paper are not unique to Safe Motherhood. They are inherent to project appraisal in the health sector. Until our information base on the mortality and morbidity impact of alternative interventions is drastically improved, analyses must be based on best estimates, and sensitivity analyses should be performed to see how conclusions change in the face of plausible variations in basic assumptions.

Finally, as mentioned earlier, workshop participants recognized that most health improvements, including maternal health, are produced jointly by the provider and the consumer, and that demand is thus one of the determinants of improved health. Successful programs in the health sector often create demand through increases in health understanding and perceived changes in the quality of care. Knowledge of precise consumer demand functions is limited, but it is often found that households spend a large proportion of their income on health care, and that improvements in quality tend to generate large increases in demand. This is an important issue, since a failure of women to use the services of these projects will result in underutilization, excessive costs per unit of service, and little impact on health outcomes. The study of the demand for these services is an issue for a future research agenda.

APPENDICES

1. LINEAR PROGRAMMING, INPUT-OUTPUT ANALYSIS, AND NON-LINEAR MODELLING TECHNIQUES COMPARED

Linear programming is a mathematical technique for the solution of problems in which maximum or minimum of a function is to be determined subject to a set of constraints. It can only be applied to problems in which all the relationships are linear; that is, for example, any given increase in an input will result in a given increase in output. An input-output model is a common approach to the analysis of an activity that uses numerous inputs to produce numerous outputs. These models define a set of inputs and outputs and, like the simpler linear programming method on which it is based, a fixed set of relationships among them (fixed coefficients).

The fixed coefficients assumption inherent in both these models presents a problem in the context of Safe Motherhood. It implies that each method of producing output (improved maternal health) uses its inputs in fixed proportions. While this may well apply to very different types of inputs (for example, you cannot make up for a lack of antibiotics by providing a woman suffering infection with more of a physician's time), it does not always apply to similar inputs (for example, you may well be able to achieve the desired effect using a midwife instead of a doctor, or by substituting between different kinds of antibiotics). This assumption is known as a "fixed coefficients" restriction, and limits the usefulness of such models for Safe Motherhood, where we assume that particular services can be delivered in a variety of ways.

A linear programming model also assumes that some fixed set of inputs is used to provide each service. Such models are able, however, to address the optimal mix of services used to satisfy the objectives of the program. Moreover, the matrix organization of such a model can accommodate both the multiple effects of interventions (e.g. improving the transportation system will have benefits beyond improving reaction time in obstetric emergencies) and the fact that some outcomes are affected by multiple interventions. It is likely that a simple linear model is currently most appropriate and achievable.

There are some restrictions imposed by the use of this model. If each Safe Motherhood intervention can be assumed to operate independently from the others, this relationship can be solved using linear programming. If, however, the level of one activity has important effects on the operation of other activities, a more complex, non-linear relationship must be specified. This may be the case with Safe Motherhood programs (e.g. nutrition education and food supplementation programs operate synergistically to improve maternal nutritional status). Non-linear models, however, are much more complicated to specify and solve than linear models. There are some measures that can be taken within a linear programming model to account for such interactions, and it is not clear that proceeding to a non-linear model at this time will yield sufficient benefits to justify the additional complication.

2. TOWARD AN ECONOMIC MODEL OF SAFE MOTHERHOOD

This section sketches out a preliminary economic model of Safe Motherhood based on the discussion at the workshop. In operation, the model can be automated so that the user is led through the steps of enumerating data and simply observing results. The model follows a very simple linear programming approach. Although in theory the economic problem to be solved could be approached using a cost minimizing or output maximizing approach, the existence of multiple outputs argues for cost minimization.

A functioning economic model would have several parts. The core of the model would be a set of equations which define the linear programming problem. These include the equation to be minimized, which sums up the cost, and a set of constraints which define the services to be provided. Other parts of the model are designed to develop the cost information and determine the services to be provided. These calculations will provide an indication of the recurrent cost. Capital investment will be determined by a separate set of equations. The linear model discussed in detail here is only part of an attempt by researchers to take a more rigorous, empirically based approach to determining the cost- effectiveness of Safe Motherhood programs. It is discussed in detail here as an expansion of the discussion at the workshop.

The first step is to construct the unit costs of activities. This is done by totaling the cost of inputs times the number of inputs used for each activity. Both the cost and the number of inputs used for a specific activity will vary by country or region, and will need to be supplied by the model user. With the basic unit costs of activities defined, the user can then proceed to define the basic objectives of the Safe Motherhood program.

The desired outcomes in the country or region may consist, for example, of a decrease in the number of mortalities or morbidities among pregnant women. To bring these outcomes about will require an increase in the volume of services provided. An important issue here is to consider the necessity of changes in the quality of services. This may require a larger quantity or variety of inputs into services that are currently being used. As knowledge of effectiveness increases, it may be possible to define more specifically the relationship between outcomes and services. For the time being, this will continue to depend on the best practices as defined by experts in the field. At this stage, however, it is probably necessary for the user to simply state the desired volume of services, which would define the basic shape of the program in that country, such as the number of women to be provided with access to essential obstetric care, number of emergency transport missions, percentage of prenatal care visits, etc.

With activities and their unit costs defined in the first step, and the service objectives of the program set in the second step, the user is ready to proceed to the optimization portion of the model. The objective here is to minimize the cost of providing these services. The computerized program would set up the optimization routine, requiring only that the user identify the relationship between activities and services. The user would be prompted to specify which activities in what quantities would be required to provide each service. There is an implicit assumption in this that activities can be substituted for each other in providing any given service,

with the user specifying the rate at which they could be substituted; this requires that the user be as knowledgeable of the production function as possible, that is, to know what and how activities can substitute for others to produce the same change in maternal health (eg midwives for physicians). The program then attempts to minimize the sum of all activities times the cost of those activities. At the same time, it faces the constraint that there must be sufficient expenditure on activities to accomplish the desired level of services.

At this point the computer program could solve for the minimum cost method of providing the required services. This solution would be specific to the country or region being examined, to the volume of services specified, and to the particular set of input costs provided to the computer program. Such a system would be able to determine the marginal cost of providing each service, the volume and combination of inputs required, and the total cost. The program could be run numerous times under different assumptions to determine a reasonable range of costs and to explore alternative program formulations.

There are a number of important features to this approach that are useful for costing, and eventually for determining cost-effectiveness. While determining the cost of inputs is a relatively straightforward, though significant process, the cost of services is unclear. Only when the composition of those services is determined can reasonable cost estimates be made. The first steps of a cost-effectiveness analysis can be found in the marginal cost estimates derived for each service. These costs can be compared to independent estimates of the relative effectiveness of each service. Eventually, as more understanding of the relationship between services and outcomes becomes known, cost-effectiveness analysis could be performed within the model itself.

The process described above can be used to determine the recurrent costs of a Safe Motherhood program. A separate set of calculations will be necessary to determine the investment costs. Users would need to determine the capital requirements of each activity, and to enumerate the existing stock of capital. After the optimization process determines the volume of services to be provided, it could then calculate the needed amount of capital. Investment needs would represent the difference between needed and existing capital.

For large scale increases in services, the capital requirements should be considered early in the process, since this can affect the relative desirability of the project. Calculating capital requirements only after having decided on the scale of activities and their recurrent cost is only acceptable when capital costs are small relative to total costs.

As stated previously, existing infrastructure (capital, personnel, etc.) should play a role in determining the shape of the contemplated Safe Motherhood program. This can be accomplished within a linear programming model by specifying that the minimum use of certain resources should be set at the currently existing stock. This is a standard economic approach to decision making known as the principle of sunk costs. Expenditures on current infrastructure are "sunk" in that they cannot be retrieved and used in a different way. Therefore, one makes decisions based on using the current capital stock. If, however, the total cost of scrapping existing stock and starting over with new investment is less than the variable cost of using sunk capital, the former option would be optimal.

3. SOME DATA ON COSTS

Three studies have included calculations of the expected cost of a Safe Motherhood program. These include the Safe Motherhood Initiative: Proposals for Action, by Barbara Herz and Anthony Measham (1987), the PAHO Regional Plan of Action for the Reduction of Maternal Mortality in the Americas (1990), and work by the Columbia University Center for Population and Family Health (1986, 1991). Most other works have used cost assumptions from these studies.

It should be noted that these studies used data from different parts of the world and from different years. The Herz and Measham paper relied primarily on data from East Africa, as well as some data from Bangladesh. PAHO estimates were from Latin America, while the Columbia data came from an extensive literature review encompassing a range of regions. Given varying socioeconomic characteristics, existing health infrastructure, needs and costs, these figures are unlikely to be comparable, nor can they be generalized to the full range of countries in which Safe Motherhood programs will need to be implemented. It should also be noted that each is based on differing assumptions regarding the impact of interventions, most of which have limited empirical basis. As such, the estimates provide little guidance to resource allocation, since cost-effectiveness comparisons cannot legitimately be made.

Workshop participants noted that there is simply no substitute for "grubbing around" at the field level, taking the time to gather information about the costs of salaries, equipment, supplies, etc., so that detailed cost tables can be constructed on a country-specific basis.

Underlying these calculations are assumptions about the unit costs of the various inputs. This section examines these unit cost assumptions and the cost of the related programs. These studies generally divide the cost of a Safe Motherhood program into community level, health center level, and a hospital level costs, though sometimes the distinctions are not absolute.

At the community level, most of the estimated costs are associated with training. Herz and Measham estimate the following annual training requirements for each type of personnel. These cost are per person in 1987 dollars.

TBAs	(5 days @ \$30/day)	\$150
Outreach coordinators	(5 days @ \$30/day)	150
Outreach volunteers	(3 days @ \$20/day)	60
Nurse-midwives	(5 days @ \$30/day)	150

These training costs per staff member are somewhat higher than PAHO estimates, even though PAHO estimates are for 1990. This may be due to better initial education and skill level for Latin American health workers than the African and Asian workers considered by Herz and Measham. PAHO estimates that continuing education for TBAs and lay midwives would cost about \$90 per person per year, and that in-service training for nurses would cost about \$250 per year.

Given their assumptions about training costs per person, Herz and Measham provide an

estimate of the annual in-service training costs needed for a district of 200,000 persons:

20 TBAs	\$3,000
20 Outreach coordinators	3,000
50 Outreach volunteers	3,000
20 Nurse-Midwives	3,000
Training for Caesarean	6,000
Training for sterilization	6,000

Transportation is a vital issue for operation of the entire Safe Motherhood Initiative. The lowest annual estimates of transportation costs come from Herz and Measham. They have the following projected costs for a district of 200,000 persons with one hospital, 8 health centers, and 20 health posts. Transportation costs include repairs, maintenance and gas (none of the three studies appear to include driver costs in these estimates):

Supervision	\$ 8,000
For clinic/hospital	\$ 7,000
Obstetrical emergencies	\$10,000

In the Columbia study, one possible program model includes an ambulance at each major health center. They estimate the annual costs of a four wheel drive vehicle for each center to be \$30,000. PAHO assumes that there should be one vehicle per hospital for the program. Extrapolating from the PAHO report, the cost estimates of these vehicles are found to be about \$100,000, with annual overhead at about 20% of the initial cost, or about \$20,000 per vehicle.

At the health center level, several estimates of staff costs are found. To be meaningful, however, staff cost estimates must be presented with an indication of their intended output. Herz and Measham make the following assumptions:

Health Center

Clinical officer (30%)	\$ 700
Nurse-Midwife (100%)	1,500
Asst. Nurse-Midwife (100%)	1,000
Aide	200
Outreach workers (2 @ 100%)	<u>1,600</u>
TOTAL	\$5,000

Health Post

Asst Nurse-Midwife (100%)	\$1,000
Outreach workers (2 @ 50%)	1,600
Outreach coordinator (40%)	<u>400</u>
TOTAL	\$3,000

The PAHO study does not estimate staff costs, but the Columbia study estimates that health centers would require a staff of five midwives at a salary of \$300 each per month at an

annual cost of \$18,000. PAHO also includes annual in-service physician training at a cost of about \$350 per year.

The PAHO and Columbia studies provide estimates of the cost of equipping this level of facility. PAHO estimates that the cost of equipping a physician's office for prenatal monitoring would be \$3,000. Columbia estimates that health center supplies and equipment would cost about \$7,000. Of course, these two facilities may be providing different levels of care, and are not strictly comparable.

At the hospital level, costs begin to rise substantially in all three studies. Herz and Measham estimate that hospital staff time for Safe Motherhood would cost about \$15,000 per year. They also include \$15,000 per year to equip and supply an operating room, and discuss additional the training needed for caesareans, sterilization, etc., but it is difficult to determine the unit costs.

These estimates are considerably lower than those of the Columbia study, which includes:

First referral facility (small rural hospital)

10 midwives at \$300 per month	\$36,000
1 physician at \$10,000 per year	10,000
Supplies and equipment	<u>20,000</u>
TOTAL	\$66,000

PAHO does not include the cost of staff time, but provides a detailed breakdown of the cost of equipment at this level:

Equipment for obstetric services at first level of referral

Anesthesia equipment	\$12,000
D&C kit	350
Minilaparotomy kit	200
Surgical instruments	7,900
Lab and blood bank equipment	<u>8,500</u>
TOTAL EQUIPMENT COST	\$28,950

There are several other aspects of these programs for which the assumptions underlying unit costs are not clear. Herz and Measham, for example, provide the cost of health education and of monitoring and evaluation without indicating the basis for their calculations. Other examples include:

From PAHO Regional Plan of Action:

Stay in maternity home	\$48
Delivery in low-risk birthing center	20
Normal delivery in birthing home	200

Dissemination of technical and scientific information	10% of training costs
Drugs and expendable items per high-risk birth	\$10
<u>FROM COLUMBIA UNIVERSITY STUDY</u>	
Prenatal visit, with vitamins and medicines	\$5

4. DETAILED AGENDA

SAFE MOTHERHOOD COSTING WORKSHOP

April 8-9, 1991

GENERAL PURPOSE: The goal of this workshop is to develop a consensus about an approach to costing Safe Motherhood programs. In approaching the analysis of any productive enterprise, economists typically try to determine what the relationship is between the resources used (inputs) and the outcomes (outputs). This relationship is generally called a production function. They also try to determine the unit costs of the various inputs being used. Armed with all this information, they will combine cost data and production functions into a new relationship known as a cost function. The cost function is the result of an optimization process. It identifies the minimum cost method of achieving any stated level of output.

This workshop will explore the possibility of developing such information for Safe Motherhood programs. To this end, the workshop will first address the question of Safe Motherhood program components, and how each part is dependent upon the other parts. We explore how to measure inputs and outputs of the program, as well as any special features that must be incorporated into production and cost functions. With this background, the workshop participants attempt to identify the most reasonable form for deriving such data. Following this discussion, participants then consider what types of data must be gathered to specify these relationships, and where that data is likely to be found. Finally, participants determine who is able and willing to assist with next steps, and agree upon a schedule.

The workshop will proceed with short presentations in each session. These will be followed by a discussion of the session questions. Moderators will keep discussion focused on the questions and will ensure that we stay on schedule. This schedule gives us only a few minutes on each question, so presenters must be brief and moderators must be disciplined about limiting the discussion to the issue at hand.

1. OPENING SESSION: 2-3:30 Room J-4009

A. Hamilton will open the workshop with comments on the importance of Safe Motherhood programs, the strength of the Bank's commitment to them, and the Bank's comparative advantage in the area.

A. Tinker will explain the purpose of this workshop, including the practical applications for the workshop results in assisting in the creation of Safe Motherhood programs. She will also briefly explain the agenda.

M. Belsey will give a short presentation on his work on proximate determinants of maternal mortality.

V. Wong will provide a conceptual framework for planning implementation of a Safe Motherhood program.

BREAK: 3:30-3:45

2. COMPONENTS OF A SAFE MOTHERHOOD PROGRAM: 3:45-5:15, Room J-4009

J. McCarthy will discuss Safe Motherhood programs and the indicators of effectiveness.

G. Walker will comment on the WHO Safe Motherhood research results and potential contributions to cost and effectiveness information.

Session Questions, V. Wong moderating:

1. What is the core package of interventions that make up a Safe Motherhood program?
2. Are there alternative compositions of Safe Motherhood programs?
3. What are the outputs? How do we measure effectiveness and impact?
4. What are the principal unanswered questions on the core program?

3. SPECIAL ISSUES IN COSTING METHODOLOGY: April 9, 9:30-11, Room H-2300

B. Herz will discuss the basic approach to costing, as applied to The Safe Motherhood Initiative.

L. Forgy will discuss what is known about Safe Motherhood costing in work to date.

J. Walsh will present a brief description of work for the Bank's Health Sector Priorities Review project.

Session Questions, B. Herz moderating:

1. What major interactions exist among parts of the Safe Motherhood program that are important for determination of costs and effectiveness?
2. To what extent do optimal program costs change with the intended scale of operation, or with social and demographic factors? Are there threshold levels of operations that are important for effectiveness?
3. What type of inputs are used in Safe Motherhood programs? Which are shared with other programs, and how can the portion used for Safe Motherhood be determined?

4. How do we measure the inputs into these programs and their costs, including possible social costs? What type of outputs can be defined? Can we use intermediate outputs, such as services, as well as outcomes, such as reductions in mortality?

BREAK: 11-11:15

4. A PRACTICAL FRAMEWORK FOR COSTING SAFE MOTHERHOOD PROGRAMS, 11:15-12:45, Room H-2300

H. Barnum will provide a general discussion of the economic issues involved in costing health services.

C. Griffin will discuss the economic relationship between inputs and outputs, and how cost issues will affect this.

Session Questions, H. Barnum moderating:

1. Can we determine a production relationship in Safe Motherhood?
2. What is a reasonable form for Safe Motherhood programs given multiple inputs and multiple outputs? Can we define a single output?
3. Can we use a simple production function? Is an input-output matrix, or other more complex nonlinear specifications required?
4. How do we measure the costs of the inputs?
5. Is it possible to derive a cost function that can be used for optimization?
6. What would be the process for this?

LUNCH: 1-2 pm.

5. DATA NEEDS: 2-3:30, Room H-2300

D. Parker will provide short comments on where and how to obtain costing data.

M. Koblinski will discuss the Mothercare Project cost related activities and possible data.

Session Questions, D. Parker, moderating:

1. What would be the practical, measurable inputs and outputs needed to quantify the

model?

2. Is this information available?
3. What field work is done or underway that can be used to obtain these data?
4. What modifications or additions would be needed in order to use this field work for our data needs?

BREAK: 3:30-3:45

6. SETTING THE RESEARCH AGENDA: 3:45-5, Room H-2300

A. Measham opens floor for discussion of session questions.

Session Questions:

1. What issues remain unaddressed by the workshop?
2. What steps will be needed to get to cost-effectiveness and benefit/cost analysis?
3. Who can participate in work of specifying the model discussed here?
4. Who can participate in extracting data from field work, including Bank operations?
How can existing field work be better utilized?
5. How can the work of the SMOR project be better utilized?
6. What are the next steps in Safe Motherhood costing work?

4. WORKSHOP PARTICIPANTS

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5. ANNOTATED BIBLIOGRAPHY

The following is a reference to some of the general works that pertain to costing issues in Safe Motherhood Programs. Annotations are made with reference to the work's pertinence to costing issues rather than a general discussion of its contents.

Assessment of Technology Needs at the First Level of Referral, Program for Appropriate Technology in Health final report to MotherCare Project, March 1990.

This very substantial report provides a large volume of medical information on requirements for essential obstetric care. It includes a literature survey, an MCH expert survey, case studies of referral centers, and other information. For costing issues, its relevance includes significant information on equipment and supplies, as well as some information on the prices of these materials.

Barnum, H., Evaluating Healthy Days of Life Gained from Health Projects, Social Science and Medicine, Vol. 24, No. 10, 1987.

This paper highlights the importance of the assumptions made when evaluating the benefits of a health project. In particular, it emphasizes the importance of properly evaluating the future healthy days of life gained by a project, demonstrating that different discount rates will change the relative ranking of competing projects. The relative value of infant and adult lives saved by a health project is of particular importance to Safe Motherhood programs.

Cost Analysis in Primary Health Care: A Training Manual for Programme Managers, A. Creese and D. Parker eds., World Health Organization, WHO/SHS/NHP/90.5.

This volume presents a practical exercise for program managers in the collection and use of cost data. While not referring directly to Safe Motherhood programs, the discussion provides useful material on the general approach to working with cost information. The book is divided into three parts: A. Unit Financial Costs, B. Cost-effectiveness Analysis, and C. Using Cost Data in Planning. Issues considered include methods of disaggregating costs into components, measuring effectiveness, accounting vs. economic costs, and methods of estimating future costs.

Essential Obstetric Functions at First Referral Level, Report of a Technical Working Group, World Health Organization, 1986.

This is a medical text, discussing the content and implementation of obstetric care at the first referral level. There is some discussion of the cost of providing this care, including buildings, equipment, supplies, personnel, and other costs, and the report concludes that, "the cost of providing essential obstetric care at the first referral level may vary greatly even from province to province and country to country according to the administrative and managerial skills deployed and the community support enlisted." Annexes provide lists of the buildings, equipment, materials and drugs needed for this care.

Fauveau, V., K. Stewart, S. A. Khan, J. Chakraborty, DRAFT: "Mortality Impact of a Community-based Maternity Care Programme in Rural Bangladesh", International Center for Diarrhoeal Disease Research, Bangladesh, 1991.

This paper reports the results of a study in the Matlab area of Bangladesh. A region of about 100,000 persons was divided into treatment and control groups, and for the period from 1984 to 1989, professional midwives were posted in the villages of the treatment area. Results showed that in the control area maternal mortality remained constant at 380 per 100,000 births, while in the treatment area it fell from 440 to 140 per 100,000 births. The report notes, however, that the treatment area made less intensive use of midwives than expected and suggests that further study is needed to determine the specific factors behind the fall in mortality, including factors that distinguish women who were attended by midwives from those who delivered alone or with traditional birth attendants.

Health of Adults in the Developing World, ed. by R. Feachem, T. Kjellstrom, C. Murray, M. Over, and M. Phillips, World Bank, 1990.

This work documents the nature and extent of adult health problems in the developing world, both in their type and evolution. It focuses on the age and disease structure of morbidity and mortality for persons aged 15 through 59 years. The book also attempts to measure the burden of adult ill health, key determinants of adult ill health in developing countries, and types of intervention strategies that could modify these determinants and improve adult health. While maternal mortality is not a major focus of the book, it does receive some attention. The book does not, however, examine "health service issues such as financing, training, decentralization or the balance among primary, secondary and tertiary facilities." Maternal health issues are placed on what the work calls "the emerging agenda for adult health." The book contains a wealth of demographic and health data.

Herz, B. and Measham, A., The Safe Motherhood Initiative: Proposals for Action, World Bank Discussion Papers, World Bank, 1987.

This study, one of the seminal pieces on Safe Motherhood programs, proposes a three part program: 1. stronger community based care, in which health workers provide screening, prenatal care, education, family planning, and other services; 2. an alarm and transport system to transfer high risk pregnancies and emergencies to referral facilities; and 3. stronger referral facilities, in both hospitals and health centers, to treat complicated deliveries, and obstetric emergencies, and to provide clinical and surgical methods of family planning. Expenditures would go primarily to increased staff, training and supervision, transport, equipment and supplies, health education, and monitoring and evaluation.

The study provides a speculative analysis of the costs of operation of two possible Safe Motherhood programs. The first is for a moderate effort in a poor, densely populated rural area with some health facilities. This program would be expected to cost \$1.50 per annum per capita, and would reduce maternal deaths by 67%. The maternal mortality

ratio would fall from 800 to 400, and increased contraception would account for the remaining reduction. The second program is a more limited effort in a very poor area with limited health care infrastructure and a weak transportation system. This effort would cost \$0.48 per capita and would prevent about 20% of maternal deaths. The maternal mortality ratio would fall from 1,000 to 950, and there would be a small increase in the contraceptive prevalence rate.

Annexes discuss several alternative configurations of Safe Motherhood programs, as well as presenting evidence from programs in Bangladesh, Brazil, Ghana, India, and China.

Maine, D. Safe Motherhood Programs: Options and Issues, Center for Population and Family Health, Columbia University, 1991.

This publication is a combination of a useful compendium of Safe Motherhood information in chartbook form, and a discussion of the analytical model of maternal mortality developed at Columbia. It documents in a straightforward manner the extent of the problem of maternal deaths and presents a model of causes of maternal ill-health and related interventions. Several possible program options are discussed, and a simple cost-effectiveness exercise is included. Details of cost assumptions are discussed in the text of this report.

Among its conclusions is the following estimated cost per death prevented by various programs:

TBA training	\$17,250
TBA new training	11,500
Prenatal care	17,692
Family planning	5,750
Health centers	4,098
Health centers and urban hospital	6,014
Health Centers and rural hospitals	3,735

Mooney, G. and Creese, A., Cost and Cost-Effectiveness Analysis of Health Interventions, World Bank, 1990.

This work, a chapter in the World Bank's Health Sector Priorities Review, provides a general discussion of the approach to cost and cost-effectiveness analysis for developing country health programs. It emphasizes a number of the principal issues in this type of analysis, including a focus on marginal costs, identification and discounting of benefits, the importance of opportunity costs, equity considerations, and problems of uncertainty. The paper makes a strong plea for setting health sector priorities "on the margin."

Regional Plan of Action for the Reduction of Maternal Mortality in the Americas, Pan American Health Organization, Washington, D.C., Sept. 1990.

This very detailed plan includes intervention strategies for a Safe Motherhood program in the Americas. The general strategy includes promotion of good health for women, including education, nutrition supplements, and family planning; training of health personnel; research on maternal mortality; improvement of information systems; and general improvement of health services. This document advocates universal coverage of health services for maternal care, a risk screening approach, a strengthened referral system, and better transportation facilities. In addition, for the poorest countries in Latin America, the plan recommends networks of homes for high-risk pregnant women. The report provides an annex with detailed estimates of the costs of the first five years of the plan.

Royston, E. and Armstrong, S., Preventing Maternal Deaths, World Health Organization, Geneva, 1989.

This well written and very readable book provides documentation of the problem of maternal mortality, delving into detail on the reliability of official statistics, the causes of mortality, consequences of the status of women in many developing countries, and the particular problems associated with abortion. Later chapters deal with maternal morbidities, and explore the role that health services and family planning can play in reducing mortality. The work is well documented and provides a comprehensive overview of the problem. There is, however, almost no discussion of the cost of maternal health interventions.

Starrs, A. and Measham, D., Challenge for the Nineties: Safe Motherhood in South Asia, World Bank and Family Care International, 1990.

This is the report of a conference held in Lahore, Pakistan in March, 1990. The report discusses the status of women's lives in South Asia, possible interventions for reducing maternal mortality, and resource mobilization and utilization requirements. In considering the costs of maternal health programs, the report quotes from the works by Herz and Measham, Walsh, et al., and Maine, et al. which are also listed here.

Walsh, J., Feifer, C., Measham, A., and Gertler, P., Maternal and Perinatal Health, Ch. 11 of Disease Control Priorities in Developing Countries, forthcoming, World Bank.

This chapter in the forthcoming World Bank study presents a detailed analysis of the causes of maternal mortality, as well as perinatal mortality. It also discusses actual and recommended practices in treatment. This study uses the same costing assumptions as the Herz and Measham study, but incorporates assumptions about the program impact on neonatal mortality. With increased contraception and the higher level of care implicit in the Safe Motherhood program, perinatal mortality is assumed to fall by 43% in the limited effort scenario from Herz and Measham, and by 79% in the more moderate scenario. The result is that the number of deaths averted increases by 24 times and 13 times in the two scenarios respectively.

Ward, V., Maine, D., McCarthy, J., and Wray, J., Indicators of Success in Programs Designed to Improve Morbidity and Mortality, Center for Population and Family Health, Columbia

University, 1990.

This paper discusses in detail the Columbia model of maternal mortality and morbidity outlined in the workshop. It lays out a set of proximate determinants of maternal health and outlines 14 possible interventions that can affect maternal health through their impact on the proximate determinants. The paper notes that "focussing on the specific interventions and how they work does not reduce the need to consider the entire process which may affect maternal outcomes." Moreover, the paper urges evaluation of interventions that considers more than each one singly and also addresses the relative importance of different interventions.

A Workbook for Policymakers: Guide for Assessing the Economic Value of Breastfeeding, Ruth Levine, Social Sector Policy Analysis Project, USAID, February, 1991.

This workbook provides a good example of how to conduct a simple benefit/cost analysis of a proposed health program by demonstrating a simple method of quantifying benefits. The book cautions that the process described is intended to provide a rough assessment of economic benefits. The book cautions that the process described is intended to provide only a rough assessment of economic benefits.

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